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Indian Standard

PROCEDURE FOR INSPECTION AND TESTING OF ALUMINIUM AND ALUMINIUM ALLOY SHEETS AND STRIPS FOR AIRCRAFT PURPOSES

(First Revision)

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Indian Standard

PROCEDURE FOR INSPECTION AND TESTING OF ALUMINIUM AND ALUMINIUM ALLOY SHEETS AND STRIPS FOR AIRCRAFT PURPOSES

(First Revision)

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Indian Standard

PROCEDURE FOR INSPECTION AND TESTING OF ALUMINIUM AND ALUMINIUM ALLOY SHEETS AND STRIPS FOR AIRCRAFT PURPOSES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 29 September 1976, after the draft finalized by the Light Metals and Their Alloys Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1969 and is being revised to bring it in line with latest international inspection and testing procedures. This standard has been prepared to cover procedure for inspection and testing of aluminium and aluminium alloy sheets and strips used for aeronautical applications.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among standards and practices prevailing in different countries in addition to the practices followed in the field in this country. This has been met by deriving assistance from the following specifications:

AIR 9050C-1964 Aluminium alloy products — Acceptance requirements. Association Francaise de Normalization.

B. S. 3L100 Procedure for inspection and testing of wrought aluminium and aluminium alloys. British Standards Institution.

GOST 12592-1967 Aluminium and aluminium alloy structural sheets. Komitet Standartov, Mer i Izmeritelnyh Priborov pri Sovete Ministrov USSR.

AMTY 515-1965 Aluminium and aluminium alloy skin sheets, State Committee of Aviation Technology of USSR.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers procedure for inspection and testing of aluminium and aluminium alloy sheets and strips used for aeronautical applications.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Approved Scrap — Scrap which is (a) derived from material the composition of which has been established with regard to the complete range of both the alloying elements and impurity elements appropriate to the class of alloy being made, and (b) segregated and identifiable to the satisfaction of the Inspecting Authority.

2.2 Billet or Slab — A cast product destined for subsequent hot-working. A rectangular billet is usually called a slab.

2.3 Cast — (a) The product of one furnace melt; (b) the product of one crucible melt; (c) the product of a number of crucible or furnace melts mixed prior to casting; (d) the amount of metal tapped from the furnace without any further addition of metal having been made (when a continuous melting process is employed); or (e) as may be otherwise defined by the Inspecting Authority.

2.4 Certification — Confirmation by the manufacturer or supplier that the material conforms to the requirements of the relevant specification, drawing, order or Inspection Schedule.

2.5 Coil — A length of a product wound into a cylindrical or annular form for convenient handling.

2.6 Harmful Defects — Any defect prejudicial to the subsequent manufacture, fabrication or use of the material (*see* Appendix A).

2.7 Heat-Treated — Annealed, solution treated, solution treated and aged at room temperature, or solution treated and precipitation treated, as stipulated in the material specification.

2.8 Inspecting Authority — The body responsible for authorizing the manufacturer or supplier to issue certification (as defined in **2.4**).

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*Rules for rounding off numerical values (*revised*).

2.9 Inspection Schedule — A schedule of any special test requirements agreed between the supplier and the purchaser.

2.10 Inspector — The individual responsible for the executive inspection and release of material.

2.11 Manufacturer — The firm that produces the material in the form (sheet, coils, etc) in which it is consigned to the purchaser.

2.12 Sheet — A cold-rolled product of rectangular section, over 0·14 mm up to and including 6·3 mm thick supplied flat with sheared or slit edges. It may be prepared as strip and subsequently flattened and cut to length.

2.13 Strip — A cold-rolled product of rectangular section, supplied in coil with slit edges, over 0·14 mm thick but not exceeding 5 mm in thickness.

2.14 Supplier — The firm that consigns the material to the purchaser.

3. CONDITION

3.1 Sheets and strips not subject to solution treatment, should be delivered in the condition stipulated in the material specification.

3.2 Sheets and strips subject to solution treatment, should be delivered in the condition stipulated in the material specification unless the manufacturer/supplier and the purchaser agree otherwise, in which case, the condition required shall be stated on the order.

4. CERTIFICATION

4.1 The manufacturer shall supply to the purchaser, necessary certificate in respect of all materials governed by this standard, and relevant material specification.

4.2 Except as provided in **4.3**, if any certificate is issued by a supplier other than the manufacturer, such supplier shall hold the equivalent certificate issued by the manufacturer.

4.3 If a batch of material consigned by the manufacturer, is sub-divided by an approved non-manufacturer before reconsignment, the non-manufacturer shall carry out any consequential additional, dimensional inspection and identification markings, and shall certify accordingly.

5. FREEDOM FROM DEFECTS

5.1 The material should be free from harmful defects. Some of the defects generally encountered are listed in Appendix A.

5.2 Any material shall be rejected for faults in manufacture although it may have been passed previously on chemical composition and mechanical tests.

6. DIMENSIONAL TOLERANCES

6.1 Thickness

6.1.1 The thickness of the sheet and strip shall comply with the requirements of Table 1.

TABLE 1 TOLERANCES ON THICKNESS

All dimensions in millimetres.

Width	Over	—		1000		1200		1500	
	Up to and Including	1000		1200		1500		1800	
Nominal Thickness		Tolerances on Thickness							
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
0·3		0·04	0·04	—	—	—	—	—	—
0·4		0·04	0·04	—	—	—	—	—	—
0·5		0·06	0·04	0·06	0·06	—	—	—	—
0·6		0·06	0·04	0·06	0·06	—	—	—	—
0·8		0·06	0·04	0·07	0·06	0·10	0·08	—	—
1·0		0·06	0·06	0·09	0·07	0·11	0·09	0·15	0·11
1·2		0·08	0·06	0·09	0·07	0·13	0·10	0·16	0·12
1·4		0·08	0·06	0·10	0·07	0·14	0·10	0·17	0·13
1·6		0·08	0·06	0·10	0·07	0·14	0·10	0·17	0·13
1·8		0·09	0·07	0·13	0·07	0·15	0·10	0·18	0·13
2·0		0·09	0·07	0·13	0·08	0·16	0·11	0·19	0·14
2·5		0·11	0·07	0·14	0·09	0·18	0·11	0·20	0·14
3·0		0·11	0·09	0·18	0·10	0·19	0·11	0·22	0·14
4·0		0·18	0·09	0·20	0·12	0·21	0·12	0·24	0·14
5·0		0·19	0·11	0·20	0·16	0·21	0·19	0·24	0·20
6·0		0·20	0·16	0·20	0·20	0·21	0·22	0·26	0·22

6.1.2 In the case of sheets and strips subject to solution treatment, the thickness shall be such as to permit compliance with the requirements of Table 2 if stated in the material specification.

6.1.3 Tolerances, on intermediate thicknesses shall be those of the next thinner materials. If the nominal mass of a lot, calculated in accordance with the material specification is less than 250 kg, the tolerances given in Table 2 shall be raised by a factor of 1·5.

TABLE 2 PLUS TOLERANCES ON MASS OF SHEET AND STRIP

(*Clause* 6.1.3)

All dimensions in millimetres.

Width					
	Over	—	1000	1200	1500
	Up to and Including	1000	1200	1500	1800
Nominal Thickness		Plus Tolerances on Mass			
		percent	percent	percent	percent
0·3, 0·4		4	—	—	—
0·5		3·5	4	—	—
0·6		3	4	—	—
0·8, 1·0, 1·2, 1·4, 1·6 and 1·8		3	4	4	4
2·0		3	3·5	4	4
2·5		2·5	3·5	3·5	3·5
3·0		2·5	2·5	3·5	3·5
4·0		2·5	2·5	2·5	2·5
5·0		1·5	2	2	2
6·0		1	2	2	2

6.2 Width and Length of Sheets

6.2.1 The width and length of sheets shall comply with the requirements of Table 3.

TABLE 3 CUTTING TOLERANCES FOR SHEETS

All dimensions in millimetres.

Width or Length						
	Over	—	1000	2000	3000	5000
	Up to and Including	1000	2000	3000	5000	—
Nominal Thickness		Tolerances on Width and Length				
Over	Up to and including					
—	3	±2	±3	±4	±7	An extra
3	6	±3	±4	±5	±7	±1 per 500 or fraction of 500

6.3 Width of Strips

6.3.1 Except as stated in **6.3.2** the width of the strips shall comply with the requirements of Table 4.

6.3.2 If specially close tolerances in the width of strips are required, they shall be half of those given in Table 4. In the case of strips up to 100 mm wide, the half tolerances shall be applied unilaterally on the plus side and in which case the Class B limits on lateral curvatures (**6.5**) shall apply.

TABLE 4 SHEARING TOLERANCES FOR STRIPS IN COIL

All dimensions in millimetres.

WIDTH	OVER	5·9	100	200	400	600	750	1000
	UP TO AND INCLUDING	100	200	400	600	750	1000	1500
Nominal Thickness		Tolerances on Width						
Over	Up to and including							
—	0·99	±0·20	±0·26	±0·40	±0·60	±1·0	±1·0	±2·0
0·99	1·99	±0·40	±0·40	±0·40	±1·0	±1·0	±1·0	±2·0
1·99	2·49	±0·40	±0·40	±1·0	±1·0	±1·0	±2·0	±2·0
2·49	2·99	±0·60	±0·60	±1·0	±1·0	±1·0	±2·0	±2·0

6.4 Lateral Curvature of Sheets

6.4.1 Unless the munufacturer/supplier and the purchaser agree otherwise, lateral curvature of sheets shall not exceed the following:

a) *Class A* (applicable to sheets over 1 m wide) — No part of the edge of any sheet shall be distant from a 3-m chord by more than 3 mm. In the case of lengths less than 3 m, the distance shall be proportionate.

b) *Class B* (applicable to sheets 1 m wide and less) — No part of the edge of any sheet shall be distant from a 3-m chord by more than 6 mm. For lesser lengths, the distance shall be proportionate.

6.5 Lateral Curvature of Strips

6.5.1 Unless the manufacturer/supplier and the purchaser agree otherwise, the lateral curvature of strips shall not exceed the following:

a) *Class A* — Each coil shall be so free from lateral curvature that when laid out flat, no part of its edge shall be distant from a 3-m chord by more than 6 mm. For lesser lengths, the distance shall be proportionate.

b) *Class B* — Each coil shall be so free from lateral curvature that when laid flat, no part of its edge shall be distant from a 3-m chord by more than 12 mm. For lesser lengths, the distance shall be proportionate.

The class of tolerance required, shall be stated on the order,

6.6 Squareness of Sheets — The diagonal distance between opposite corners of any sheet shall not differ by more than the total tolerance on the length of the sheet.

6.7 Flatness (Applicable only to Sheets and Strips Subject to Solution Treatment) — If required, a standard of flatness for sheets and strips shall be agreed between the manufacturer/supplier and the purchaser.

7. CHEMICAL COMPOSITION

7.1 The chemical composition of the material should comply with the requirements of the material specifications*. The values stipulated in the specification shall be applied in accordance with the instructions of Inspecting Authority. Elements not included in the specifications should not be added for any purposes other than fluxing, degassing, grain refinement and the like. The overall control of chemical composition and the regulation for the use of scrap should be such that the method of analytical control adopted for each particular material, should enable Inspector to certify compliance with the requirements.

7.2 The manufacturer shall make an entry in his register of the melt and the chemical composition, as and when regular lots are melted.

NOTE — Removing of defects within the thickness limits of the gauge on clad sheet is likely to lead to removal of the cladding material and therefore a deleterious effect may be created.

8. SELECTION AND PREPARATION OF MECHANICAL TEST SAMPLES

8.1 Selection of Test Samples

8.1.1 *Applicable to Sheets and Strips Not Subject to Solution Treatment* — Sheets and strips of the same nominal thickness and condition, from the same cast and, if annealed, that have been annealed together, shall be grouped in batches of not more than 2 000 kg. (If an individual coil exceeds 2 000 kg that coil shall be deemed to represent one batch.)

8.1.2 *Applicable to Sheets and Strips Subject to Solution Treatment* — Sheets and strips of the same nominal thickness, from the same cast and that have been heat-treated together shall be grouped in batches of not more than 100 sheets or 20 coils.

8.1.3 The inspector shall select a minimum of one test sample from each batch, after straightening, for the specified tensile test.

8.1.4 If hardness tested, the tensile test sample shall be selected from the sheet or coil of lowest hardness in the batch, in the case of material subject to solution treatment.

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*In the case of clad sheets and strips, sample for chemical analysis shall be taken after removal of cladding.

8.2 Preparation of Test Specimens

8.2.1 The test specimens should be prepared in accordance with the requirements of IS : 1816-1961*.

8.2.2 A test specimen shall be cut from each test sample in such a way that its longitudinal axis is parallel to the direction of final rolling, in the case of materials less than 30 cm width, and at right angles to the final rolling direction when width is 30 cm and over. The test specimen shall be duly identified.

8.2.3 *Applicable to Sheets and Strips Not Subject to Solution Treatment* — Test samples selected in accordance with **8.1** should not be heated or mechanically worked after having been separated from the material they represent.

8.2.4 *Applicable to Sheets and Strips Subject to Solution Treatment*

8.2.4.1 If the material is in annealed condition, it shall be solution-treated and naturally aged or solution-treated and precipitation-treated as required by the material specification and shall not be further heat-treated or mechanically worked before being tested.

8.2.4.2 If the material is in solution-treated and naturally aged condition and if the precipitation treatment is required in accordance with material specification, it shall be carried out. However, the material should not be subjected to a further cycle of heat treatment nor mechanically worked after having been separated from the material they represent.

9. MECHANICAL TESTING

9.1 Tensile Test — One specimen cut and prepared as specified in **8** and tested in accordance with IS : 1816-1961* shall satisfy the appropriate tensile requirements of the material specification.

9.2 Bend Test — Bend test need be carried out only if stated in the purchase order. After bending, there shall be no evidence of splitting or cracking on the external bend surface. 'Orange' skin is permissible. The bend radii shall be agreed upon between the manufacturer/supplier and the purchaser.

9.3 Hardness Test (Applicable only to Material Subject to Solution Treatment)

9.3.1 If the material is not clad and is in solution-treated and naturally aged condition or solution-treated and precipitation-treated condition, each sheet or strip and tensile test piece shall be hardness tested.

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*Method for tensile test for light metals and their alloys.

9.3.2 Unless the tensile test sample was selected in accordance with **8.1.4**, the Brinell or Vickers hardness number of each sheet or strip in each batch shall not be less than the number that is *X* percent below that of the tensile test pieces, where *X* is given the appropriate value stated in the material specification.

Note — The value of *X* depends on the tensile strength of the test piece.

9.3.3 The manufacturer shall establish to the satisfaction of the Inspecting Authority, limiting values appropriate to the material specification. Due account should be taken of the possible value of setting both lower and upper limits of hardness and the need for limiting values appropriate to certain thickness. The hardness of each sheet or coil should comply with the limit or limits so agreed.

10. SPECIAL TESTS

10.1 Checking for Salt-Petre Traces (Applicable to Material Heat-Treated in Salt Bath)

10.1.1 Apply a few drops of diphenylamine in sulphuric acid [to 0·5 g of diphenylamine, add 10 ml of distilled water and 25 ml of sulphuric acid, (r.d. = 1·84) dissolving the diphenylamine. Bring the volume of solution to 100 ml by adding H_2SO_4 (d = 1·84)]. Development of intensive blue colour within 10 to 15 seconds indicates presence of salt-petre on the given surface. After testing the drops shall be removed by filter paper, washed thoroughly and dried.

If presence of salt-petre is observed, the sheets shall be subjected to repeated washing and checking for salt-petre.

10.2 Checking for Coarse Crystalline Structure

10.2.1 A strip shall be cut along the whole width (not less than 40 mm) and pickled in 5 to 6 percent caustic soda solution at 50°C for 1 minute followed by cleaning in 30 percent nitric acid solution. If coarse crystalline structure appears on the surface, the sheet or coil shall be rejected.

10.3 Checking for Cladding Thickness (Applicable to Clad Sheets and Strips)

10.3.1 Cladding shall be spot checked by dipping in freshly prepared 10 percent caustic soda solution for 10 minutes. Appearance of blackish stain indicates insufficient cladding thickness or excessive diffusion of copper into the cladding in which cases the cladding shall be measured microscopically (*see* **10.4.1**).

10.3.2 The cladding thickness, percent, measured microscopically shall be within the limits specified in the material specification.

10.4 Checking for Copper Diffusion in the Cladding (Applicable to Clad Sheets and Strips)

10.4.1 Microexamination shall be carried at on mounted sections of sheets or strips after due polishing and etching with suitable reagent. The diffusion shall not extend to the outer surface.

11. RETESTS

11.1 If any test specimen fails to satisfy the specified tensile test requirements, the Inspector shall adopt one or both of the following procedures, as requested by the manufacturer:

a) Select for test from the same batch two further test samples, one of which shall be taken from the sheet or strip from which the original test sample was taken, unless it has been withdrawn by the manufacturer. Both test specimens prepared from these retest samples shall satisfy the tensile test requirements.

b) Allow the sheet or strip to be re-annealed in the case of annealed condition or reheat-treated in accordance with the material specification and retested in accordance with the requirements of **8**, **9.1**, **9.2**, **9.3.1** and **9.3.2**. However, the material shall not be reheat-treated more than once.

12. IDENTIFICATION

12.1 Each sheet, strip or coil, passed by the Inspector, shall bear the mark of the inspector and such other markings as shall ensure full identification of the material.

12.2 If required by the material specification, except as otherwise agreed between the manufacturer and the purchaser and stated on the order, one side of each sheet or coil of strip, passed by the Inspector, shall be marked ' all over ' (possibly by line-stencilling with removable non-corrosive paint, 250 mm apart) with specification number, manufacturers' identification symbol and condition.

13. CORROSION PREVENTION

13.1 The identified sheets and coils of strips shall be coated with suitable temporary protective with or without interleaving non-corrosive paper (oil paper) before transit or storage.

14. PACKING

14.1 Unless otherwise specified, the sheets and strips shall be oiled/greased and packed with interleaving paper to avoid any chafing. Grease and paper shall be neutral and non-corrosive. The whole package shall be wrapped in strong waterproof paper in such a way as to avoid ingress of moisture, dust, etc, and shall be placed in a box or crate with a view to prevent any displacement of sheet metal. Gluing of sheet surfaces with neutral sticky paper in places is also permissible to prevent chafing in place of interleaving paper.

APPENDIX A

(*Clauses* 2.6 *and* 5.1)

HARMFUL DEFECTS

A-1. Some harmful defects are burrs on the edges, layer-splits in the edges, cracks, tears, non-metallic inclusions, blisters, deposit of salt-petre, diffusion spots, corrosion patches, coarse crystalline structure, scratches deeper than clad layer, waviness, oil canning effects, laps, deep roller marks, etc.

A-2. Defects which are removable by burnishing or cleaning with a crocus cloth but within the acceptable thickness limits are permissible.

A-3. Very deep scratches extending beyond cladding thickness on skin sheets meant for exposure to weather conditions are not permissible.

(*Continued from page* 2)

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'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001	2 63 48
‡ Peenya Industrial Area, 1st Stage, Bangalore-Tumkur Road, BANGALORE 560058	39 49 55
Gangotri Complex, 5th Floor, Bhadbhada Road, T.T. Nagar, BHOPAL 462003	55 40 21
Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002	5 36 27
Kalai Kathir Building, 6/48-A Avanasi Road, COIMBATORE 641037	2 67 05
Quality Marking Centre, N.H. IV, N.I.T., FARIDABAD 121001	—
Savitri Complex, 116 G. T. Road, GHAZIABAD 201001	8-71 19 96
53/5 Ward No. 29, R.G. Barua Road, 5th By-lane, GUWAHATI 781003	3 31 77
5-8-56C L. N. Gupta Marg, (Nampally Station Road) HYDERABAD 500001	23 10 83
R14 Yudhister Marg, C Scheme, JAIPUR 302005	6 34 71
117/418 B Sarvodaya Nagar, KANPUR 208005	21 68 76
Plot No. A-9, House No. 561/63, Sindhu Nagar, Kanpur Road, LUCKNOW 226005	5 55 07
Patliputra Industrial Estate, PATNA 800013	6 23 05
District Industries Centre Complex, Bagh-e-Ali Maidan, SRINAGAR 190011	—
T. C. No. 14/1421, University P. O., Palayam, THIRUVANANTHAPURAM 695034	6 21 04

Inspection Offices (With Sale Point) :	
Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010	52 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	5 24 35

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*Sales Office Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, CALCUTTA	27 68 00
† Sales Office is at Novelty Chambers, Grant Road, BOMBAY	89 65 28
‡ Sales Office is at Unity Building, Narasimharaja Square, BANGALORE	22 39 71

Reprography Unit, BIS, New Delhi, India